Chapter

Pregnancy, Children and Inter-Relating Factors Affected by Geohelminthiasis

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Abstract

A life-threatening parasitic infection arising in evolving countries, principally prevalent in children below 5 years and pregnant women, has led to the growing interest for understanding the condition acknowledged as geohelminthiasis. Decreased cell-mediated immunity (a necessity in fetal retention) leading to a compromised immunological response is what makes pregnant women more prone to the infection thereby increasing the risk of maternal anemia, preterm deliveries and stillbirths based on reports. An outcome of geohelminthiasis on children is its deteriorative effect on cognition. This chapter highlights the relationship between the helminthic infection with respect to pregnant women and children additionally focusing on other associated factors such as poverty, hygiene, etc. that further contribute to the decline in quality of life in developing countries.

Keywords: geohelminthiasis, cell-mediated immunity, cognition, pregnancy, parasitic infection

1. Introduction

The general term used to describe a worm is referred to as a "helminth." These invertebrates fall under two categories, namely flatworms or Platyhelminthes (flukes and tapeworms) and roundworms or Nematoda [1, 2]. They either survive in aquatic and terrestrial environments as parasites or free of a host. Out of the various types, intestinal nematodes or soil-transmitted helminths (STH) also known as "Geohelminths" are the most common worldwide. The World Health Organization (WHO) claims that 1.5 billion people worldwide, constituting to 24% of the world's population, are infected by STH; with wide distributions in the Sub-Saharan Africa, America, China and East Asia in tropical and subtropical regions [3].

The major infection of STH originates from the attack of *Ascaris lumbricoides* (commonly called the large intestinal roundworm or the common roundworm) and *Trichuris trichiura* (whipworm) [4, 5]. Hookworm (Ancylostomatidae) affliction is also another most common chronic infection found in humans that contribute to STH [6].

Children are the frequent victims to an STH attack as many of them are school aged, living in areas of extensive disease transmission; requiring treatment interventions and preventive measures [7]. Secondary victims of this infection are pregnant women reported every year, among which 44 million are estimated to be affected globally [8]. Improvements in potable water services, drainage, sanitary food control, living quarters, individual and community anti-vector action are a few conceptualizations that can be implemented for the eradication of this infectious outbreak [9].

The central focus of this chapter is to gain insight into as to how aspects of childhood and pregnancy are concomitant to geohelminthiasis, along with various other inter-relating factors such as poverty, hygiene, etc.; that cause a drop in the quality of life in developing countries.

2. Immune responses to STH

Preclinical data from animals suggest that th2 (T-helper) cells are triggered by cytokine release along with immunoglobulin E (IgE) of the host immune system aiding in the elimination of helminthic burdens [10, 11]. However, the innate and adaptive immunity are often markedly found to remain suppressed. This indicates that immune responses triggered due to a helminthic infection could result in host protection responses against microbial pathogens to be antagonized [12, 13]. Recent findings of the involvement of macrophages referred to as alternatively activated macrophages can also be a contributing factor leading to an inflammatory response when in contact with a helminth [14].

3. Children and geohelminthiasis

School children of countries affected by this epidemic, were found to exhibit the greatest incidence and severity of the outbreak. No ill effects (with respect to morbidity) were thought to be experienced by children with light infections. However, recent evidences oppose this traditional notion with reports of slight or minimal intensity outbreaks having significant decrement in the development and growth of children [15]. Information regarding as to how various factors affect geohelminthiasis in children is discussed below.

3.1 Nutrition

Nutrition plays a key role as a target for the alleviation of helminthic infections. Several surroundings of the developing world are impacted by malnutrition and helminthic infection, both as their main or supplementary factors governing mortality [16]. Impaired digestion, malabsorption, diminution in food consumption and poor growth rates are often noted in children who endure this helminthic incursion [17]. Recent studies also depict the fact that malnutrition is in direct proportion to the intensity of the pathogen Ascaris [18]. Other factors governing infection scale include the extent of nutritional deficiency and concurrent prominence of single or multiple infections and single or multiple nutritional deficiencies [19]. Increased loss of endogenic protein paired with the distress of energy and mineral metabolism are the mechanisms by which an intestinal nematode reduces feed intake by the host. Better nutrition can improve the rate of adult worm rejection via an approach of diet consumption rich in metabolizable proteins [20].

The improvement of the nutritional status of school children would be an essential remedy for disease alleviation [21, 22].

3.2 Environment

The environmental variables attributing to the risk of this parasitic outbreak cannot be avoided as a correlation between this aspect and disease condition is of high prevalence.

Recent studies of various schools reporting the presence of certain other influential environmental factors governing the infection such an inadequate water supply, requirement of regular water/sanitation maintenance regimes and overcrowding in classrooms can be taken into consideration for disease management [23].

3.3 Anti-helminthic treatment in children

Since the primary mode of therapy includes the use of anti-helminthics, development of resistance due to their administration is a crucial factor governing geohelminthiasis. The known variables that add value to an anti-helminthic resistance are medication frequency, refuge or the percentage in the parasite population not exposed to drugs and the possibility of underdosing [24].

Another causative factor in children leading to intestinal obstruction observed was prior anti-helminthic treatment [25]. Although specific IgE antibodies are believed to participate in the protection against helminthic infection, the polyclonal stimulation of IgE caused by helminthic parasites could be the sole reason for re-infection [26]. In a follow-up investigation concerning growth retarded children where anti-helminthic therapy was discontinued after successful alleviation; the extent of re-infection was found to dramatically increase which could pose difficulty in the quality of life of the concerned [27].

3.4 Cognition

The negative influence of STH infections on cognitive processes, notably in school children; has been deduced by researchers since 1900. Prolonged anemia and toxemia were factors accountable for the substantial increase in the degree of cognitive delay with respect to the level of infection. However, clarification remains to be produced regarding the mechanism by which worms impact cognition. Certain postulates comprise of malnutrition and fatigue in children troubled from the infection as consequences of diminished cognition. Reports of medication reversing this adverse effect are also at large and very much essential for effective control of the disease [28–30].

4. Pregnancy and geohelminthiasis

Helminthic infections are suggested to be extremely damaging, with detrimental effects on maternal anemia and birth outcomes in cases of pregnancy, with a total global impact on pregnancies estimated to be 44 million [31, 32].

4.1 Probable mechanism of susceptibility to STH in pregnancy

A characteristic feature of pregnancy is the successful retention of the fetus due to hormonal, dietary and immunological changes occurring during the period [33]. This is a unique illustration of how the body adjusts to a destructive immune response during pregnancy [34]. Therefore, studies have clearly defined the characteristic of pregnancy as immune modulation and not its suppression. In other words, an alteration to the immune system contributes to differential responses not merely on the basis of microorganisms but on the basis of stage of pregnancy [35].

Although the periparturic immunosuppression involvement remains unclear, one of the proposed mechanism depicts the avoidance of particular processes of host immune defense by the parasitic helminth [36, 37]. The resemblance between the immune reactions to helminths and pregnant females may be a sign that tolerance may be invoked by analogous mechanisms (i.e., type 2 responses). Another suggestion has been that helminths may have undergone self-adaptation in order to combat immune responses from the mother by utilizing the similarity in mechanisms as used by a human fetus [38]. These could have been some among the many reasons a pregnant mother's susceptibility to helminthic attack is widespread.

The WHO reports that far more than half of the pregnant females in emerging economies have concerns pertaining to iron deficiency anemia, which could be a result of an elevated metabolic requisite for iron during childbirth coupled with poor nutrition. This iron STH related deficiency has been concomitant to augmented mortality rate, premature birth and low birth weights during the period of pregnancy [39, 40].

4.2 Co-infection

Considering pregnancy, the susceptibility to co-infections cannot be ignored due to immunological modulations associated with the stage. Data indicating the exhibition of higher prevalence of *Trichuris trichiura*, followed by an *Ascaris lumbricoides* infection were found in cases of pregnancy; where attacks of a single infection was found to be at a higher percent than that of co-infections [41]. Considering co-infections associated with pregnancy related STH, it was found that the malarial parasite *Plasmodium falciparum* co-existed with hookworms, when compared to roundworms and whipworms [42, 43].

4.3 Geophagy (soil eating)

Another causal component for STH diseases is geophagy that is practiced among some African females. While the exact reason remains a mystery, some beliefs such as curing heartburn and alleviating morning sickness are still at large [44]. Adequate data indicates that geophagy can be associated with enhanced anemic peril and reduced hemoglobin amounts [45]. Geophagy in lactating mothers resulted in reinfection and hence was advised for immediate interventions to tackle disease transmission [46].

4.4 Maternal anemia

The greater the severity of hookworm infestations, the greater was the percentage of blood loss or anemia observed in pregnant women from an endemic area survey [47]. During pregnancy, the hookworm, in particular, was considered to be the source of mild associative anemia while the other STH's were involved in mild deficiencies of iron [48, 49]. A current connection between co-infection and anemia, as reported in the latest studies indicate that the latter is not a sole companion of helminthic attack alone [50].

Since there is an additional relationship between anemia and birth outcomes (increased risk of preterm birth or low birth weight), a helminthic outbreak could also be affiliated to the second during pregnancy [51]. All the above findings indicate that the association of anemia due to STH can be debilitating in case of pregnant women.

4.5 Birth outcomes

The reason for the problem of low birth weight was the exposition to an attack of hookworm resulting in intrauterine growth retardation especially in cases of HIV infected subjects [52]. A lower prevalence of low birth weight was the end result of periodic anti-helminthics and the weekly iron folic acid supplements before pregnancy [53]. Another birth outcome experienced was the premature birth. Similar to the case of maternal anemia, the co-existence of other infections with STH brought about a greater negative birth outcomes.

5. Present beneficial hypotheses

Although helminthic infections are difficult for kids and for pregnant females, the asymptomatic stage in an helminthic infection was found act as a guard keeper against immunological syndromes [54]. An unusual, inflammatory bowel disease (characterized by chronic gastrointestinal inflammation) hygiene hypothesis suggests a lack of exposure to intestinal helminths as an important environmental factor contributing to the development of such illnesses [55, 56].

The possibility of predisposition to Crohn's disease (an inflammatory idiopathic bowel disease, most often involving the ileum, colon and in certain cases; the esophagus) due to lack of exposure to helminthic parasites as per data of a certain study [57, 58]. A similar small cross-sectional study showed the prevalence of STH to have beneficial effects in patients with type 2 diabetes (insulin resistant). However, this may seem to be damaging in areas where helminthic treatment options are a must to curb disease morbidity [59].

6. Other inter-relating factors

All the above discussed variables associated with children and pregnant women are also dependent on conditions of on geographical circumstances, poverty and bad hygiene. The STH assault is restricted to rural regions of tropics, especially in coastal regions; where temperature, humidity and soil type are appropriate for development and growth. Exposure to larval eggs in farming areas where individuals expose their skin to the hot and humid soil is what aids in disease transmission. Sandy soils provide better growth conditions for these worms when compared to clayey soils. An important adverse link between socioeconomic status and incidence or severity of helminthic disease can also attribute towards the spread of STH. It was found that the prevalence of disease was less in cases of higher income groups. Bad sanitation or hygiene due to the lack of income is also an associated factor leading to an attack of STH [60–63].

7. Conclusion

Geohelminthiasis or soil-transmitted helminthiasis is recognized as a life-threatening parasitic outbreak in developing nations, predominantly in kids under 5 years of age and pregnant females and has resulted to increased concern. Reports of nutrition, environment, resistance to treatment and cognition were the associative parameters found in children, whereas in the condition of pregnancy existence of co-infections, geophagy, maternal anemia and birth outcomes were found to be the inter-relating variables to STH. The avoidance of particular processes of host immune defense and self-adaptation to combat immune responses from the mother by utilizing the similarity in mechanisms as used by a human fetus were the proposed mechanisms by which pregnant women are more prone to the attack. All the associative parameters discussed above were found to increase disease burden. Tackling these factors is therefore a must for achieving an improved quality of life.

Although recent or upcoming beneficial hypotheses could play an important role in the eradication of associative diseases, the same benefit could have least highlighting phenomena when poverty is involved. Improvements in hygiene and improved access to anti-helminthic drugs are some of the factors that could establish a better alleviating status for the disease attack. Further researches/studies and proper awareness among groups where the disease is endemic is however still a requisite for both devising and strategizing to fight against the disease.

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Conflict of interest

We the authors would like to declare that there is no conflict of interest based on the information produced.

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